

CHAPTER 9

POST-TREATMENT

9-1. General. Desalination can and most often does produce water so free of dissolved material that corrosion and potential health problems are possible. Electrodialysis reversal is an exception to this general rule. Electrodialysis reversal does not remove microorganisms.

9-2. Remineralization and aeration. Pure water is a relatively reactive chemical. When air is dissolved in extremely pure water, the resulting solution is extremely corrosive. Water without dissolved air tastes flat and objectionable. Water that contains very little hardness appears to be unhealthy for drinking purposes. Therefore, the designer of a desalination system must consider some posttreatment options, such as remineralization and aeration, in order to produce a healthful, noncorrosive, pleasant-tasting water.

9-3. Post-treatment of distilled water. The mineral content of distilled water is much lower than is considered healthy for drinking purposes. Distilled potable water should be aerated and remineralized for health, taste, and to prevent corrosion. Some radionuclides may not be removed by distillation/condensation, which may require post-treatment by ion exchange, prior to all other post-treatment methods.

a. Reaeration. Distilled potable waters will be reaerated before use. Cascade, eductor, or sprayed aeration are acceptable but must be followed by disinfection to prevent bacterial contamination.

b. Mineralization. Recent studies have indicated that the hardness of drinking water is important for human health. The Langelier Corrosion Index was developed to predict the tendency of water to deposit or dissolve calcium carbonate. Recalcification of distilled water will be performed in order to reach a positive Langelier Corrosion Index by adding lime. Fluoridation of Army potable water supplies is discussed in TB MED 576.

c. Corrosion control. Distilled water has a greater corrosion potential once it is aerated.

Any boiler feed water should bypass reaeration where possible. Corrosion should be controlled by the addition of sodium hexametaphosphate or sodium silicate, in conjunction with remineralization, prior to entry into the distribution system.

The Langelier Corrosion Index can be adjusted to a slightly positive value by pH adjustment. The adjustment of the distilled water pH should occur immediately after reaeration, prior to distribution, as airborne carbon dioxide may influence the pH.

d. Residual disinfection. Residual disinfection should be present in the active parts of the distribution system. A break-point chlorination curve is shown in figure 9-1. Chlorine disinfection of very pure water leads to a chlorine residual that is free of combined chlorine or chloramines. Chlorination of distilled water systems should occur immediately prior to the distribution system. Where it is convenient or economical, calcium hypochlorite should be used to control pH to aid in recalcification and to disinfect the distribution system. Disinfection of Army potable water supplies is discussed in TB MED 229 and TB MED 576.

e. Reblending for remineralization. One of the most cost-effective ways to remineralize distilled water is to blend a small stream of pretreated saline feed water back into the distilled product water. When bacterial contamination is sufficiently low and hardness is sufficiently high, then reblending is an acceptable means of distilled water remineralization. When reblending is practiced, boiler feed water should be removed from the system upstream of the reblend point. Saline water used for reblending must have a 30-minute chlorine contact time. This chlorinated reblend stream is an excellent method of providing the total chlorination for the distribution system. As further discussed in Chapter 10, brine can be used to electrolytically produce hypochlorite ion for disinfection.

9-4. Post-treatment of reverse osmosis product water. Unlike distilled water, reverse osmosis product water is not necessarily free of dissolved gases. If degasification is not used as a pretreatment step, the dissolved gas content of the reverse osmosis product stream will be roughly that of the feed stream.

Since divalent and trivalent ions are better eliminated by reverse osmosis than are monovalent ions, reverse osmosis product water is usually very soft and has a hardness level that is unhealthy when used as drinking water.

a. Corrosion control. As a consequence of the dissolved gas content of the reverse osmosis product water, corrosion control should occur as close as is convenient to the suck-back tank.

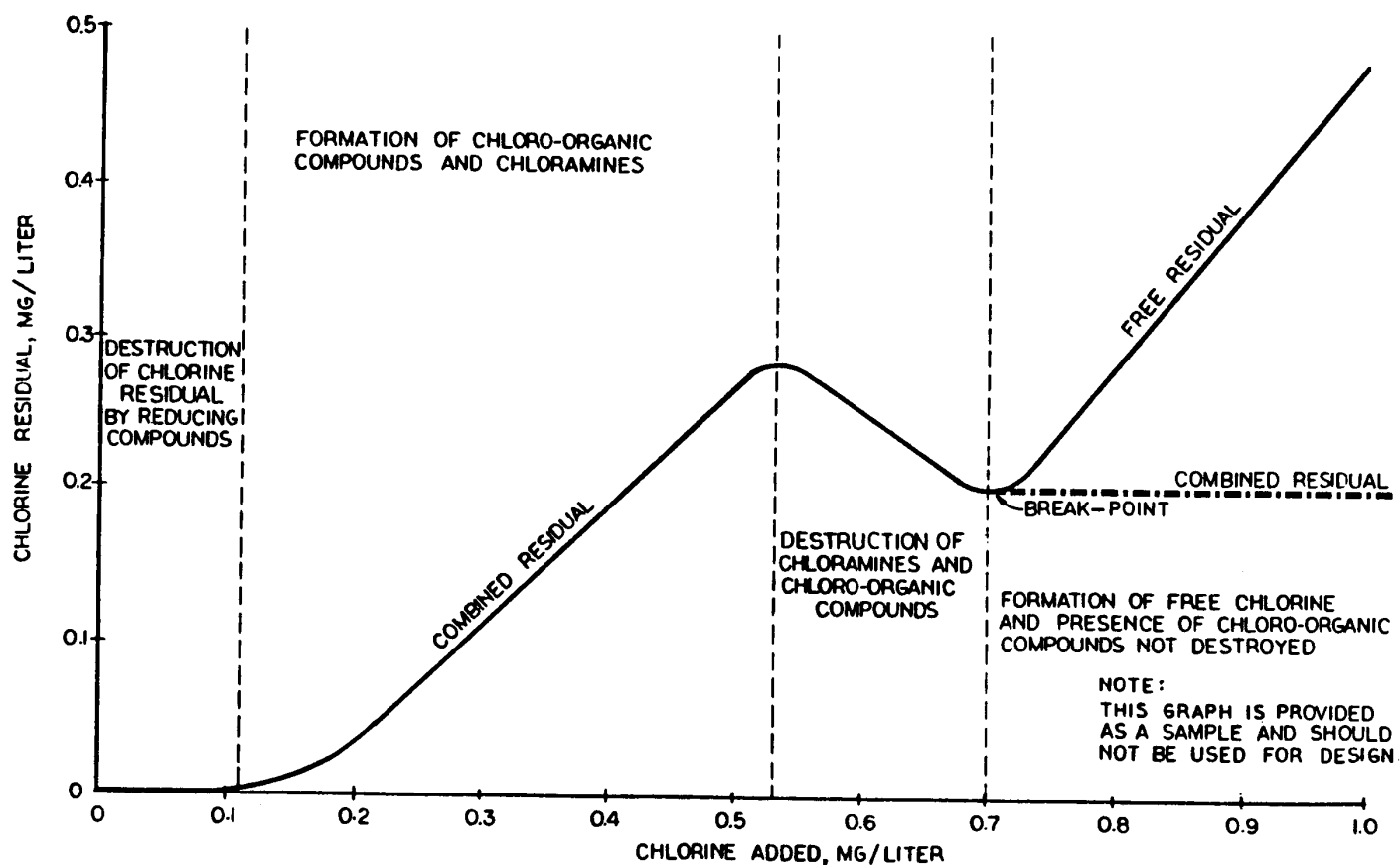


Figure 9-1. Break-point chlorination curve.

A high carbon dioxide content in reverse osmosis product water contributes to corrosion. This is true, particularly where acid is fed for scale control.

A degasification tower is used to obtain equilibrium with atmospheric carbon dioxide. Degasification should occur after remineralization. Boiler feed water or wash water should be drawn off prior to corrosion control.

To control corrosion of reverse osmosis product water, add sodium silicate or sodium hexametaphosphate. Corrosion control is affected by recalcification and Langelier Corrosion Index adjustment.

b. Reverse osmosis remineralization. Occasionally, remineralization of reverse osmosis product water is not necessary. Since reverse osmosis increases the monovalent-to-divalent ion ratio, remineralization is usually advisable. This remineralization, will contribute to the production of a pleasant tasting and healthful product water.

c. Residual disinfection. The use of calcium hypochlorite for disinfection will assist in remineralization.

d. Reblending. Reblending of pretreated saline water is an acceptable remineralization procedure for reverse osmosis product water as long as the hardness of the reblend can be shown to be healthful. All reblended water must receive a full 30-minute chlorine contact time.

9-5. Post-treatment of electrodialysis-reversal product water. Electrodialysis reversal does not remove small suspended material. The pretreatment for electrodialysis reversal should remove any material that will plug a 10-micron filter. Loosened scale and particulate matter may require postdesalination removal. Micro-organisms are not removed by electrodialysis reversal.

a. Suspended solids removal. Suspended solids removal during pretreatment is the preferred design for electrodialysis-reversal facilities. Pretreatment of suspended solids removes particulates, including micro-organisms, which are prone to blind electrodialysis-reversal membranes. This removal reduces the time between cleanings. When electrodialysis-reversal product water turbidity cannot be controlled economically by pretreatment, then an attempt will be made to eliminate all pretreatment suspended solids

control. If this is feasible, suspended solids control will be a post-treatment process at the electrodialysis-reversal facility. When it is impossible to centralize all turbidity control, and electrodialysis reversal is still shown to be economical, both pretreatment and post-treatment suspended solids control shall be designed. At high-current densities, electrodialysis reversal will soften water by the selective removal of multivalent ions. At low-current densities, electrodialysis reversal can be used to selectively remove monovalent ions. This selective removal of monovalent ions at low-current densities can be economical for fluoride or other exotic ion removal or control where total dissolved solids and other ions are not a problem.

b. Remineralization. Remineralization of electrodialysis-reversal product water is seldom necessary. When recalcification is deemed desirable, it is generally best to make provisions for adding calcium carbonate.

c. Residual disinfection. Disinfection chlorination of electrodialysis-reversal product water should occur as soon as possible after electrodialysis-reversal desalination. Electrodialysis reversal will remove most of the free available chlorine used in any pretreatment chlorination. Electrodialysis reversal can lead to a greater concentration of bacteria in the product water than was present in the feed stream due to osmotic loss of water to the waste brine stream. Chlorination of all electrodialysis reversal waters will include a 30-minute chlorine contact time after treatment. Pretreatment chlorination will not be included as part of the 30-minute contact time. The operation and design of electrolytic hypochlorite production equipment, as listed in Chapter 10, is similar to the electrodialysis process. This can make electrolytic production an operational and strategic advantage for electrodialysis-reversal desalination facilities.